

## Redescription and Range Extension of *Bathydoris aioca* Marcus & Marcus, 1962 (Nudibranchia: Gnathodoridoidea)

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**Abstract.** *Bathydoris aioca* Marcus & Marcus, 1962, originally described from Baja California, is the only species of this genus known from the Pacific coast of North America. Examination of the original type material and newly collected specimens from Oregon, allows a redescription and range extension of this species. The digestive, reproductive, and central nervous systems are studied and re-illustrated, and scanning electron micrographs of the radula are presented for the first time. A comparison with other species of the genus leads to the conclusion that it constitutes a valid species.

### INTRODUCTION

*Bathydoris aioca* is the only species of this genus known from the Pacific coast of North America. It was originally introduced by Marcus & Marcus (1962) on the basis of a single specimen collected from Baja California, Mexico, at 2753–2808 m depth. In the original description, details of the reproductive, digestive, and central nervous system morphology were overlooked. No additional specimens have been studied since the original description.

Lance (1967) rediscovered the holotype of this species and deposited it in the collections of the Department of Invertebrate Zoology and Geology of the California Academy of Sciences (CASIZ). He cited this species under the incorrect spelling *Bathydoris aioca*. No further descriptions of the animal are given in that paper.

The present paper redescribes *B. aioca*, based on a re-examination of the holotype and 12 additional specimens collected from Oregon, which constitute the second record of this species.

### SPECIES DESCRIPTION

*Bathydoris aioca* Marcus & Marcus, 1962  
(Figures 1–6)

**Type material:** Holotype (by original designation): Northeast of Isla Guadalupe (29°40.2'–29°45.4'N, 117°06.6'–117°09.9'W), Baja California, Mexico, 2753–2808 m depth, 15 February 1960, 71 mm preserved length, leg. R. Parker (CASIZ 018839). Lance (1967) mentioned the California Academy of Sciences type series number for this species (306), which is no longer in use as the catalogue number.

**Additional material:** Off Oregon coast (44°35.5'N,

125°35.3'W), USA, 2800 m depth, 29 April 1963, 1 specimen 47 mm preserved length, R/V *Acona*, cruise 6304 (CASIZ 115223). Off Oregon coast (44°44.5'N, 125°42'W), USA, 2850 m depth, 29 December 1963, 1



Figure 1

*Bathydoris aioca*, external morphology. A. Dorso-lateral view of a preserved specimen (CASIZ 115222), scale bar = 5 mm. B. Lateral view of a preserved specimen (CASIZ 115225), scale bar = 5 mm.

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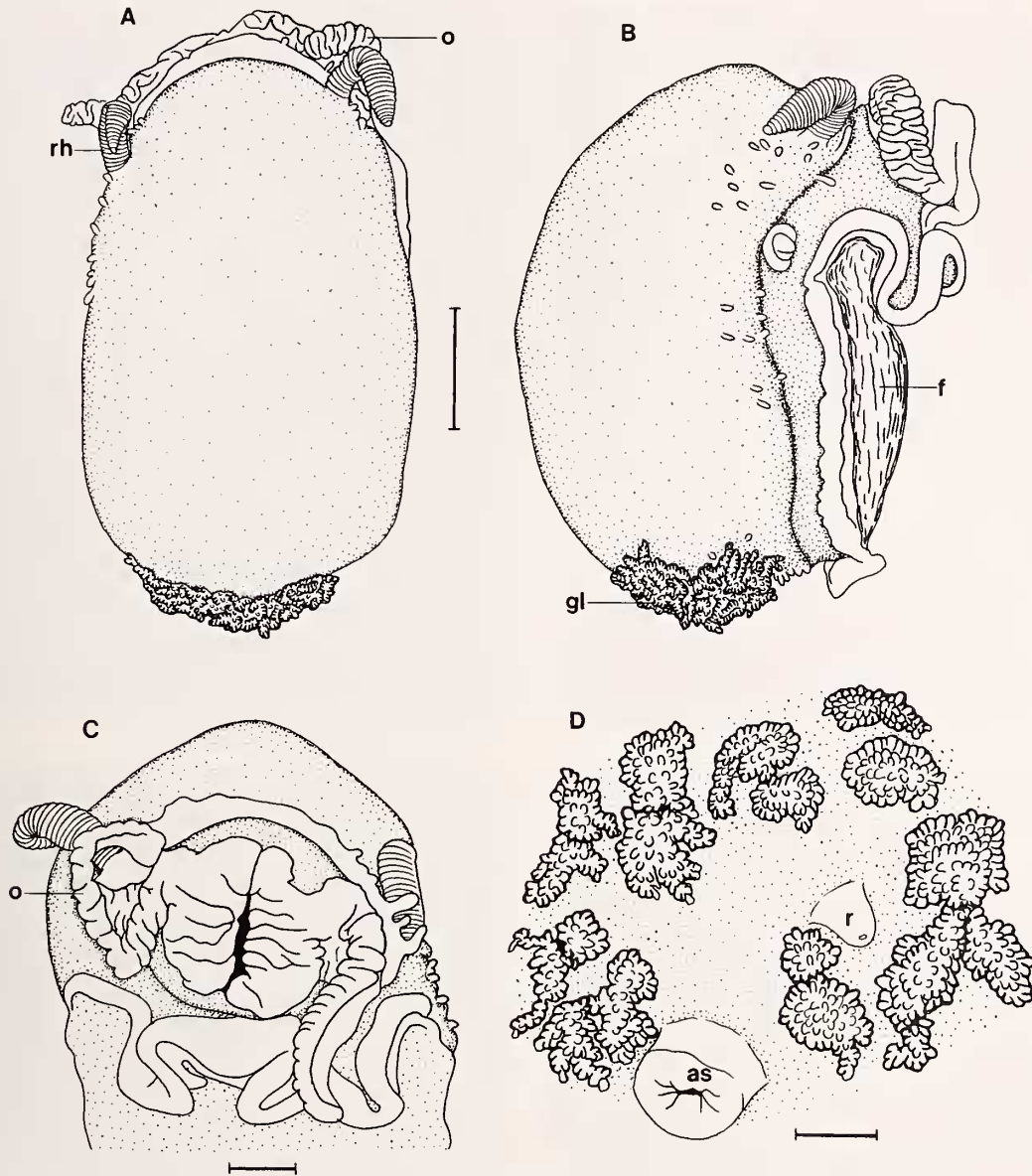


Figure 2

*Bathydoris aioca*, external morphology. A. Dorsal view of a preserved specimen (CASIZ 113314), scale bar = 5 mm. B. Lateral view of a preserved specimen (CASIZ 113314), scale bar = 5 mm. C. View of the mouth area (CASIZ 113314), scale bar = 2 mm. D. Branchial leaves arrangement (CASIZ 018939), scale bar = 5 mm. Abbreviations: as, anus; f, foot; gl, gill; o, oral tentacle; r, renal opening; rh, rhinophore.

specimen 23 mm preserved length, R/V *Acona*, cruise 6312 (CASIZ 115225). Off Oregon coast (44°44.8'N, 125°59.5'W), USA, 2800 m depth, 12 January 1965, 1 specimen 33 mm preserved length, R/V *Acona*, cruise 6501 (CASIZ 113315). Off Oregon coast (44°42.0'N, 125°37.3'W), USA, 2800 m depth, 20 February 1965, 1 specimen 23 mm preserved length, R/V *Acona*, cruise 6502 (CASIZ 113314). Off Oregon coast (44°39.2'N,

125°35.3'W), USA, 2810 m depth, 27 March 1966, 1 specimen 36 mm preserved length, R/V *Yaquina*, cruise 6503 (CASIZ 115224). Off Oregon coast (44°32.5'N, 125°24'W), USA, 2772 m depth, 9 April 1965, 1 specimen 35 mm preserved length, R/V *Yaquina*, cruise 6504 (CASIZ 115226). Off Oregon coast (44°44.3'N, 125°41.4'W), USA, 2800 m depth, 24 October 1965, 1 specimen 15 mm preserved length, R/V *Yaquina*, cruise

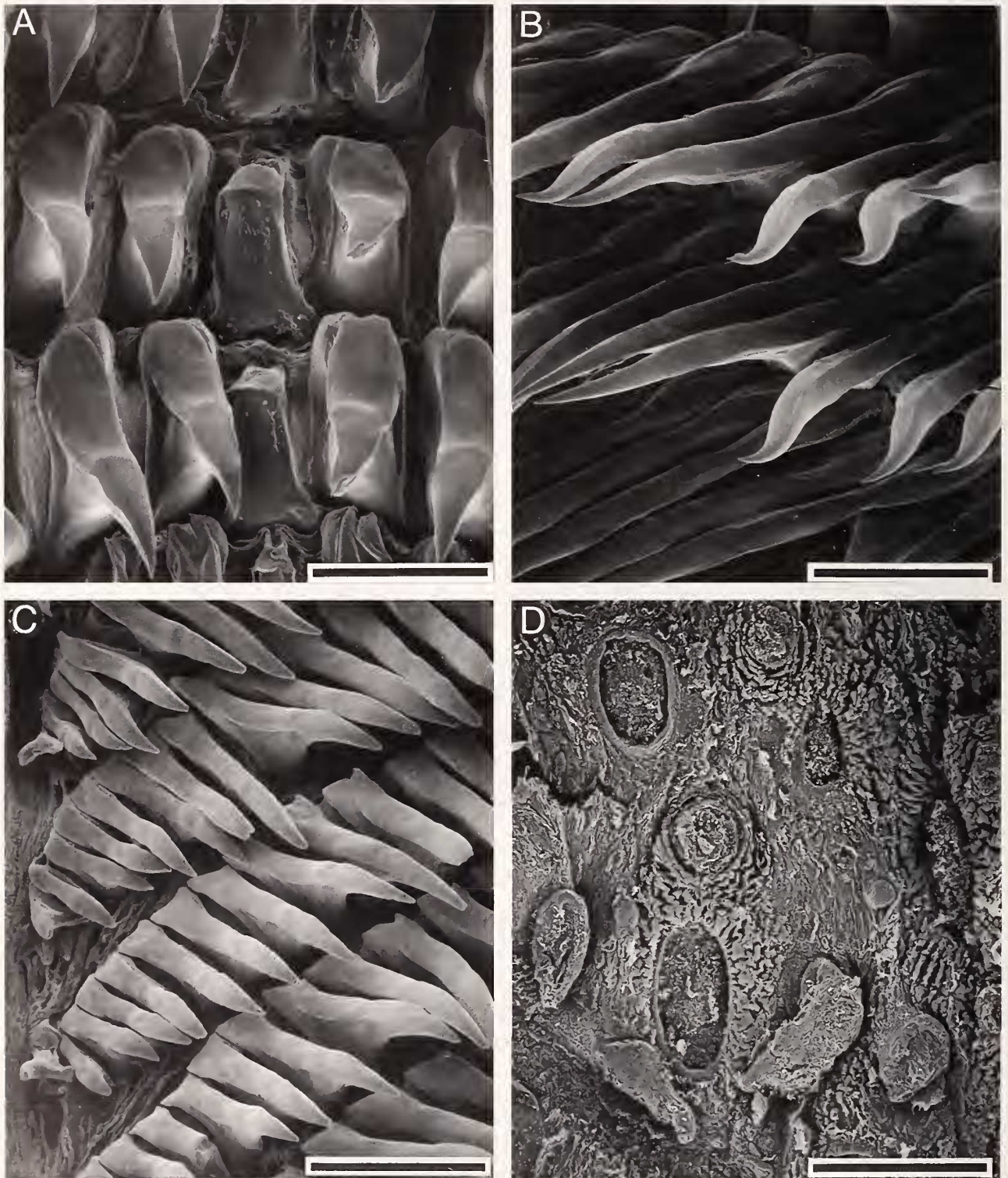


Figure 3

*Bathydoris aioca*, scanning electron micrographs. A. Rachidian and inner lateral teeth of the radula (CASIZ 018939), scale bar = 250  $\mu\text{m}$ . B. Mid lateral teeth of the radula (CASIZ 018939), scale bar = 300  $\mu\text{m}$ . C. Outer lateral teeth of the radula (CASIZ 018939), scale bar = 250  $\mu\text{m}$ . D. Tubercles and depressions of the mantle (CASIZ 018939), scale bar = 750  $\mu\text{m}$ .

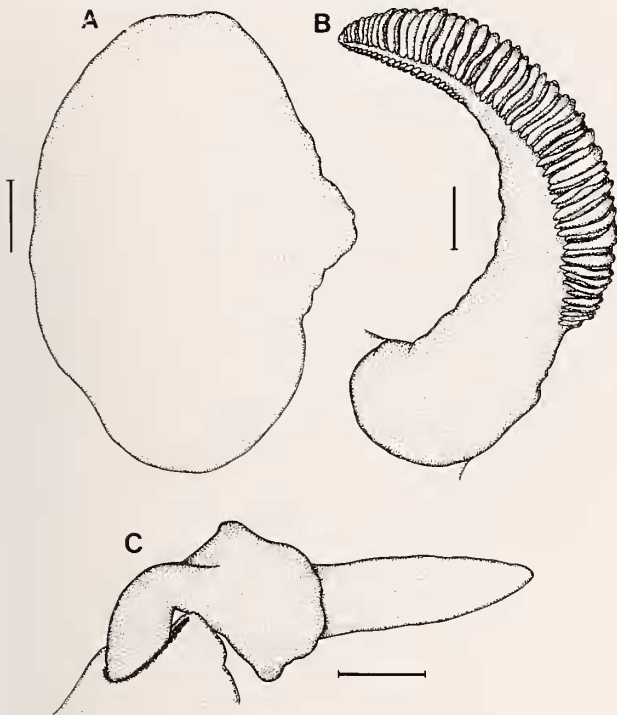


Figure 4

*Bathydoris aioca*. A. Jaw (CASIZ 113315), scale bar = 2 mm. B. Rhinophore of the holotype (CASIZ 018839), scale bar = 2 mm. C. Penis of the holotype (CASIZ 018839), scale bar = 5 mm.

6510 (CASIZ 115222). Locality and data unknown (probably from the same area), 5 specimens 15–31 mm preserved length (CASIZ 113316).

**External morphology:** The color of the living animals is unknown. Preserved specimens are uniformly pale brown, lacking spots or traces of other colors. The body texture is soft, lacking spicules. In the dorsum, the tegument is very thin and the viscera are visible through the skin. The body is oval, elevated (Figures 1, 2A, B), with the rhinophores situated near the anterior edge of the notum. The gill is situated close to the posterior end of the notum. The dorsum is covered with small oval depressions (Figure 3D) which probably correspond to the place where the tubercles were attached in the living animal. Some minute, tentacular tubercles (Figures 1, 2A, B, 3D) remain in the laterals of the notum, anterior region of the body, and around the gill. The mantle margin is very narrow, only clearly visible in the anterior part of the body. The rhinophores are very elongate (Figure 4B). They have 45 large lamellae alternating with the same number of small ones in a 71 mm preserved length specimen. The gill consists of 18 bipinnate branchial leaves in a 71 mm preserved length specimen (Figure 2D). Each branchial leaf emerges from a depression in the mantle,

independently from the others. Very often the branchial leaves are arranged forming pairs, but they have been considered as two different leaves when they originate from different depressions in the surface of the mantle. The anus protrudes posteriorly (Figure 2D), closing the circle of branchial leaves. The renal pore also visibly protrudes (Figure 2D). The foot is strongly muscular and as long as the notum. It projects backward in a small tail. The oral tentacles are two long, flattened, lateral prolongations of the mouth area (Figure 2A–C).

**Anatomy:** The buccal bulb consists of a large, oval muscular mass (Figure 5A). The jaws are two large, smooth plates (Figure 4A). They have thin growing marks crossed by radial lines. Except for that, there are no other marks or microsculpture. The radular formula is  $64 \times (81.1.81)$  in the holotype (71 mm long preserved specimen) and  $53 \times (64.1.64)$  in a 33 mm preserved length specimen. The rachidian teeth are rectangular plates, lacking denticles (Figure 3A). The lateral teeth have a single elongate cusp, also lacking denticles (Figure 3B). The inner lateral teeth are very similar in shape to the mid laterals, but the cusp is shorter (Figure 3A). The outer lateral teeth are much smaller than the mid laterals, having also the same shape (Figure 3C). The two large, flattened salivary glands are connected to the laterals of the buccal bulb through two long ducts. The esophagus opens in the posterior end of the buccal bulb. It is short and wide, with the internal walls lined by strong ridges. These ridges are covered by a thin cuticle. Posteriorly, the esophagus opens into a muscular stomach, situated ventrally in the viscera. Two ducts emerge at the end of the stomach (Figure 5C); one is the intestine, and the other is a short duct which opens into the digestive gland.

The reproductive system is dialic (Figure 5B). The ampulla is a long, very convoluted tube. It branches into a short oviduct and the prostate. The prostate is a long, highly convoluted undifferentiated duct. It expands distally into the muscular ejaculatory portion. The vaginal duct is wide and long. It runs inside of the female gland most of its length. Near its distal end the vaginal duct connects with the bursa copulatrix. The penis is long and smooth, lacking hooks (Figure 4C).

In the central nervous system (Figure 6) the cerebral and pleural ganglia are separated and also distinct from the pedal ganglia. The cerebral ganglia are very large and they appear to be divided in two regions. From each cerebral ganglion emerge five nerves. No visceral loop has been observed. At the end of the optic nerves no eyes have been observed though careful examination, and this species is probably blind. The rhinophoral ganglia are situated in the middle of the cerebral ganglia. The pleural ganglia are small; from each one emerge seven nerves. The pedal ganglia are twice as large as the pleural. From each one emerge three nerves, the pedal and parapedal commissures. Also, from the right pleural ganglion

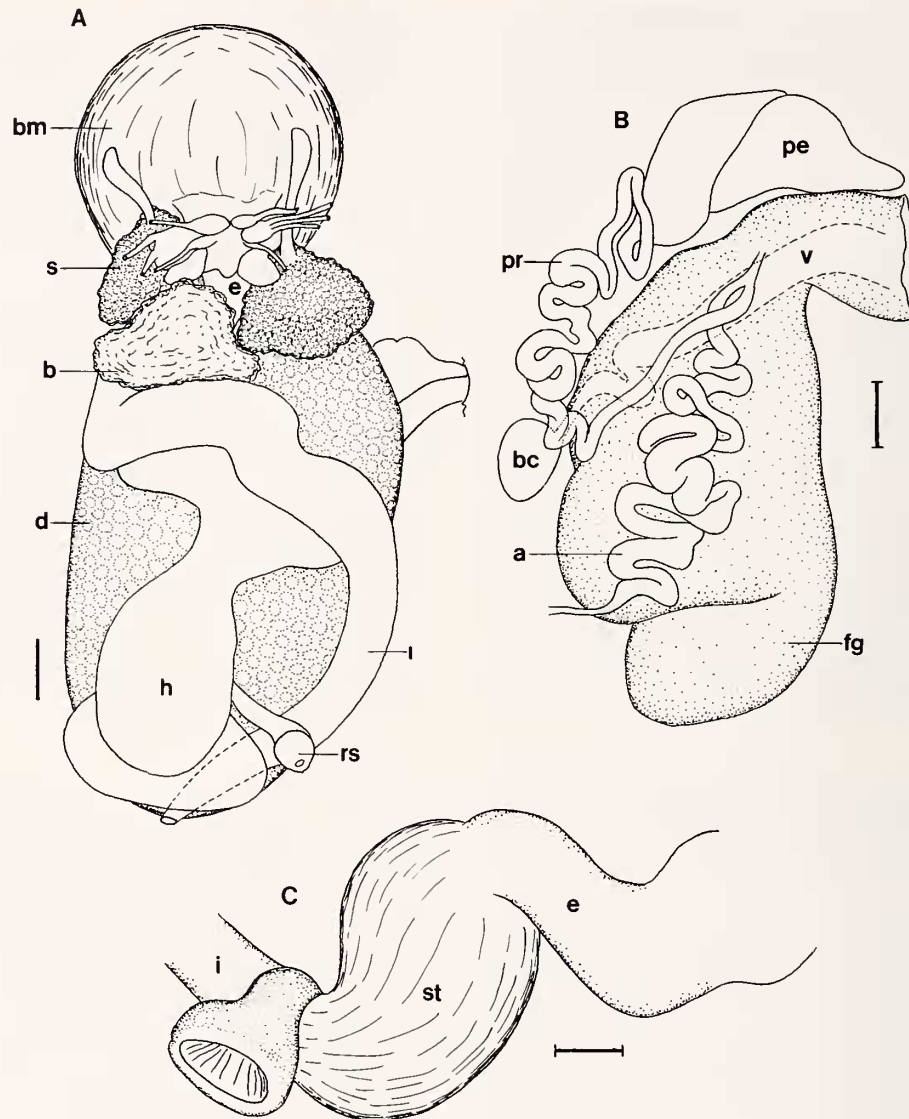


Figure 5

*Bathydoris aioca*, anatomy. A. Dorsal view of the internal organs (CASIZ 113316), scale bar = 2 mm. B. Reproductive system (CASIZ 113315), scale bar = 1 mm. C. Dissected digestive tract (CASIZ 113316), scale bar = 2 mm. Abbreviations: a, ampulla; b, blood gland; bc, bursa copulatrix; bm, buccal mass; d, digestive gland; e, esophagus; fg, female gland; h, heart; i, intestine; pe, penis; pr, prostate; rs, renal sac; s, salivary gland; st, stomach; v, vaginal duct.

emerges the genital nerve. The buccal ganglia are as large as the pleural and are joined together by a long commissure. Two nerves and the cerebral-buccal connective have been observed emerging from each one.

The circulatory system consists of a large heart and a single blood gland situated behind the central nervous system (Figure 5A). The renal sac opens directly on the renal pore (Figure 5A). We did not observe glands in the dorsal pericardial walls or in the distal ureter, as Wägele (1989) described for *B. hodgsoni* and *B. clavigera*, re-

spectively, but that could be due to the poor preservation of our specimens.

## DISCUSSION

The study of additional specimens of *Bathydoris aioca* in the present paper allows a more detailed comparison with other known species of the genus. The specimens from Oregon show no external or anatomical differences with the holotype from Baja California, and are obviously conspecific.

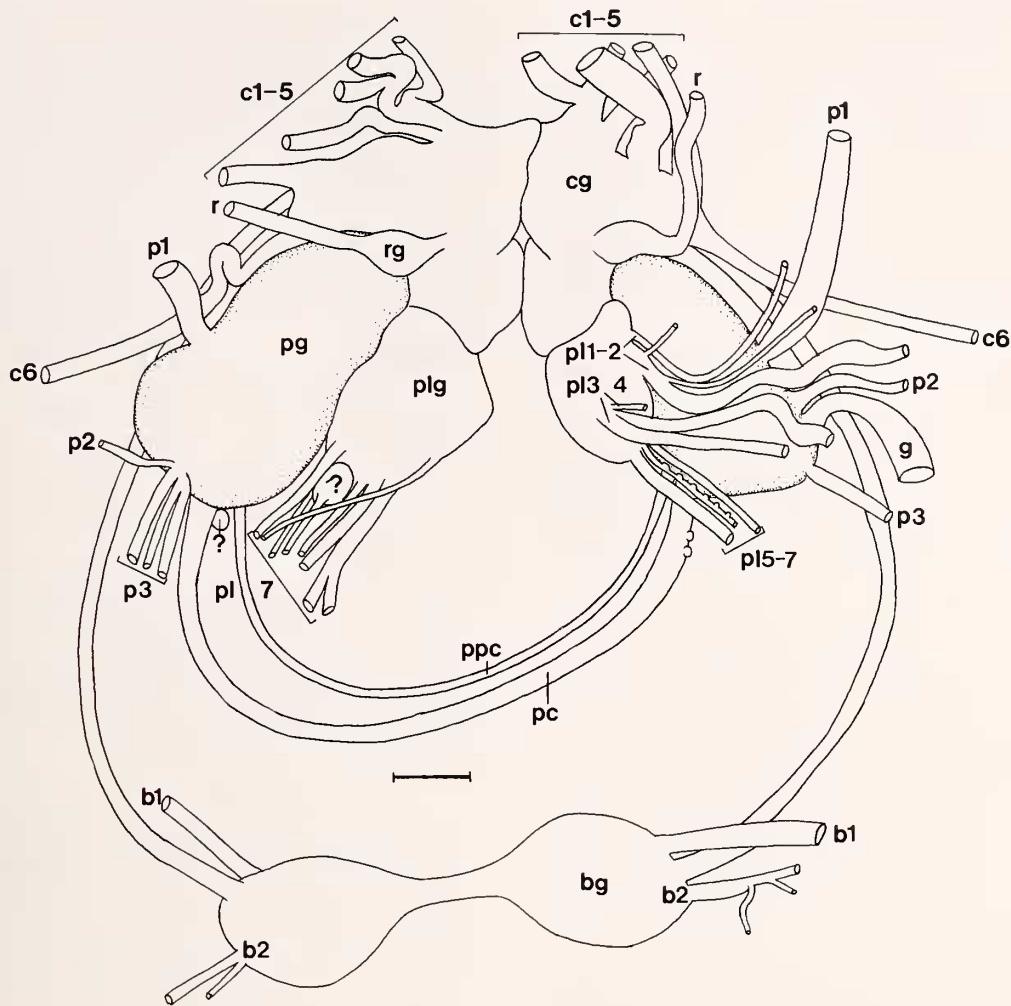


Figure 6

*Bathydoris aioca*, central nervous system (CASIZ 113315), scale bar = 1 mm. Abbreviations: b, buccal nerve; bg, buccal ganglion; c, cerebral nerve; cg, cerebral ganglion; p, pedal nerve; pc, pedal commissure; pg, pedal ganglion; pl, pleural nerve; plg, pleural ganglion; ppc, parapedal commissure; r, rhinophoral nerve; rg, rhinophoral ganglion.

Wägele (1989) reviewed the Antarctic species of the genus *Bathydoris* Bergh, 1884, comparing them with other species of the genus. She concluded that *Bathydoris clavigera* Thiele, 1912 (synonyms: *B. obliquata* Odhner, 1934, and *B. argentina* Kaiser, 1980), *B. hodgsoni* Eliot, 1907 (synonyms: *B. inflata* Eliot, 1907, and *B. brownii* Evans, 1914), *B. vitjazi* Minichev, 1969, *B. abyssorum* Bergh, 1884, *B. ingolfiana* Bergh, 1900, *B. aioca* Marcus & Marcus, 1962, and *B. patagonica* Kaiser, 1980, can be considered as valid species. This conclusion was based on the re-examination of the holotypes of several species and a review of the literature. Only two species, *B. clavigera* and *B. hodgsoni* were anatomically studied. The holotype of *B. aioca* was not studied for that paper. In the meanwhile, another new species, *B. violacea* Baranets,

1993, was introduced from Antarctica (Baranets, 1993).

*Bathydoris aioca* is easily distinguished from *B. clavigera* and *B. hodgsoni*, the two species fully described by Wägele (1989). The radular rachidian teeth of *B. clavigera* have two cusps, which are absent in *B. aioca*, and the inner lateral tooth is very different in shape from the rest of the laterals, whereas in *B. aioca* it is very similar. The vaginal duct of *B. clavigera* is very short and wide, and runs externally to the female gland, whereas in *B. aioca* it is long and thinner, and runs inside of the female gland mass. Externally, the gill of *B. clavigera* is in a central position and the body is flattened, whereas the gill of *B. aioca* is close to the posterior end of the notum, and the body is very high. *Bathydoris hodgsoni* is also

different from *B. aioca* in the radular morphology. The rachidian teeth of the former are triangular and have one cusp, whereas in *B. aioca* the rachidian teeth are rectangular and smooth. *Bathydoris hodgsoni* shares with *B. aioca* a long vaginal duct running inside the female gland, the gill situated close to the edge of the notum, and the absence of eyes. Other differences are that the penis of *B. hodgsoni* has numerous pits and folds, but it is smooth in *B. aioca*; and the blood gland of *B. hodgsoni* is situated behind the intestine, whereas in *B. aioca* it is situated below.

Other Antarctic or southern species are *B. vitjazi*, *B. patagonica*, and *B. violacea*, all of them incompletely described. *Bathydoris vitjazi* also lacks eyes, but the foot is very small compared to the body. According to Wägele (1989) the number of branchial leaves of *B. vitjazi* can be interpreted as seven. These features are very different from that of *B. aioca*, which has a foot as large as the notum and 18 branchial leaves. *Bathydoris patagonica* is also clearly different from *B. aioca*. The former has a very large buccal area (see Kaiser, 1980), the body is more flattened than in *B. aioca*, the foot is larger, the jaws are broader, and the rachidian teeth of the radula are triangular, being rectangular in *B. aioca*. According to Wägele (1989), *B. patagonica* could constitute a geographical variety of *B. hodgsoni*. *Bathydoris violacea* is also an eyeless species that differs from *B. aioca* in the rhinophore position, which is far anterior in *B. aioca* and farther back in *B. violacea* (see Baranets, 1993). The radular morphology of both species is also different. The rachidian teeth of *B. violacea* have one cusp, whereas those of *B. aioca* are smooth. The innermost lateral teeth of *B. violacea* are very different from the rest, they are wide and short, with a small cusp, whereas in *B. aioca* the innermost lateral teeth are similar to the other laterals, having an elongate cusp. In addition, the body of *B. violacea* is elongated, having a posterior prolongation resembling a tail. In *B. aioca* the body is oval and elevated, lacking any posterior prolongation in all specimens examined.

The two other species of *Bathydoris* described from the

Pacific Ocean are *B. abyssorum* and *B. ingolfiana*. Both differ from *B. aioca* in details of the external morphology and anatomy. According to Wägele (1989), *B. abyssorum* has only five branchial leaves (in a 120 mm long specimen), a small foot, and appears to have two vesicles in the reproductive system; *B. ingolfiana* has seven branchial leaves (in a 90 mm long specimen) and also a small foot, whereas *B. aioca* has 18 branchial leaves in a 71 mm preserved length specimen, the foot is as large as the notum and has only one genital vesicle. Detailed anatomical studies on additional specimens of *B. abyssorum* and *B. ingolfiana* are necessary for completion of the diagnostic features of both species.

We were unable to find the visceral loop in the three specimens of *B. aioca* examined, as well as Wägele (1989), in *B. clavigera* and *B. hodgsoni*. According to Wägele (1989), it is probable that it lies very close to the pedal and parapedal commissure within a common sheath of connective tissue.

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#### LITERATURE CITED

- BARANETS, O. N. 1993. The primitive nudibranchiate mollusc: *Bathydoris violacea* sp. n. (Gastropoda, Nudibranchia). Vestnik Sankt-Peterburgskogo Universiteta (3) 3:13–18 [in Russian].
- KAISER, P. 1980. Die Gattung *Bathydoris* Bergh, 1884 in patagonischen Gewässern. Spixiana 3:43–51.
- LANCE, J. R. 1967. The holotype of the abyssal dorid nudibranch *Bathydoris aioca* Marcus & Marcus, 1962. The Veliger 9: 410.
- MARCUS, EV. & ER. MARCUS. 1962. A new species of the Gnathodoridacea. Anais da Academia Brasileira de Ciências 34: 269–275.
- WÄGELE, H. 1989. A revision of the Antarctic species of *Bathydoris* Bergh, 1884 and comparison with other known bathydorids (Opisthobranchia, Nudibranchia). Journal of Molluscan Studies 55:343–364.